SUBSURFACE INVESTIGATION

AND

ENGINEERING ANALYSIS

FOR

LOWER SHOAL CREEK RESTORATION PROJECT

HIKE & BIKE TRAIL SLOPE STABILIZATION

2500 LAMAR BOULEVARD

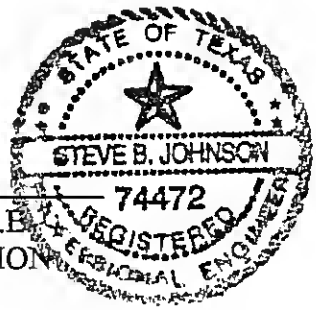
AUSTIN, TEXAS

RAYMOND CHAN & ASSOCIATES

1102 WEST AVENUE

AUSTIN, TEXAS 78701

PREPARED BY:



STEVE B. JOHNSON, P.E.
GEOTECHNICAL DIVISION

FILE NO. 01-03298
2 MARCH 1998

JACK H. HOLT Ph.D. & ASSOCIATES, INC.
2220 BARTON SKYWAY
AUSTIN, TEXAS 78704
PH. 512/447-8166 • FAX 512/447-0852

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AUSTIN, TEXAS 78704
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INTRODUCTION

An investigation of subsurface conditions for the Lower Shoal Creek Restoration Project for the Hike and Bike Trail Slope Stabilization Project off Lamar Boulevard in Austin, Texas was authorized in a meeting on 13 January 1998 with Mr. Tom Hegemier, P.E. of Raymond Chan & Associates. The purpose of this investigation has been to determine subsurface materials and conditions at the proposed site and to establish design and construction criteria for the project features that will be affected by subsurface materials.

The number and location of the borings were determined and located in the field by representatives of Jack H. Holt & Associates, Inc. The borings were drilled to appropriate depths to provide a general soil profile across the area.

SCOPE OF INVESTIGATION

The following investigation and engineering studies were performed in connection with the preparation of this report:

1. Three borings were made in order to:
   - A. Determine subsurface materials present at the site.
   - B. Obtain samples and cores of subsurface materials for laboratory analysis.
   - C. Investigate existing in-place conditions of subsurface materials by examination and field tests.
   - D. Investigate groundwater conditions at the site.

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2. Samples of subsurface materials were analyzed as necessary in the field and laboratory by:

   A. Visual examination and classification.

   B. Atterberg Limits tests.

   C. Minus No. 200-Mesh Sieve tests.

   D. Dry Unit Weight and Moisture Content.

   E. Unconfined Compression Tests.

3. Analyses were made of field logs, field tests and laboratory tests to determine allowable soil bearing pressures, foundation type, and construction problems. Details and results of the investigation are discussed in the following paragraphs.

SUBSURFACE EXPLORATION

Subsurface materials at the site were explored by three soil borings drilled to depths ranging from 25 feet to 30 feet below the existing ground surface. All holes were logged in the field and in place soils were sampled where possible. Grab samples were taken from the auger flights while undisturbed samples were taken using a Shelby Tube Sampler. Standard penetration tests were performed by using a 2 inch O.D. Split-Spoon Sampler driven by a 140 pound hammer dropping 30 inches. The inches of penetration of the Split-Spoon due to 50 blows of the hammer were recorded and are shown on the attached Logs of Borings. Laboratory tests were run on selected samples and the results of these tests are also shown in the attached Logs of Borings.

GENERAL SITE DESCRIPTION

The project site is located on Shoal Creek on the west side of Lamar Boulevard (2500 Block) in Austin, Texas. An area of the west bank of Shoal Creek along the existing hike and bike trail has eroded and collapsed into the creek. Barricades have been placed on each end of the damaged area. The length of the erosion is approximately 400 feet long. Shoal Creek Drive (2600 Block) crosses Shoal Creek just to the north of the site. Several underground sewer lines exist in the area.

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SUBSURFACE CONDITIONS

The soils are described in more detail by the attached boring logs. In general, alluvial soils are found on the surface and consist of sandy silts, sandy clays and silty clay. These soils extend to depths ranging from 8 feet to 12 feet and overly a greenish tan and gray silty clay that extends to a depth ranging from 12 feet to 20.5 feet. Below this a formation of gray limestone rock is found and extends to termination of the borings at 25 feet to 30 feet.

The alluvial soils vary in sand content and are low to moderate in plasticity. The tan greenish tan and gray silty clay is high in plasticity ranging from 32 to 41. Standard penetration tests in the greenish tan and gray silty clay range from 22 to 35 blows per foot indicating a high shear strength. The gray limestone is weathered in the upper portion with interbedded silt layers and with depth is less weathered and more intact.

Groundwater was encountered in borings B-2 and B-3 and 9.0 feet and 6.5 feet respectively. We expect the water level will be at or near the standing pool level in the creek and will vary accordingly.

DISCUSSION AND RECOMMENDATIONS

It is our understanding the west bank of Shoal Creek is to be stabilized with a retaining structure in order to prevent further erosion and to support the hike and bike trail above. It is further our understanding the structure should blend in with the natural terrain by using large limestone blocks, gabions, reinforced earth or other similar type construction.

The primary concern for this structure is proper seating of the footing into a suitable strata that will not be undermined or eroded by undercutting of the creek. We prefer that all footings or piers under the structure be placed into the limestone rock formation, however, based on our elevation survey the rock formation is approximately 7 feet to 12 feet below the existing channel bottom. In order to achieve proper bearing into the rock, it will be necessary to use drilled straight shaft piers. This will in our opinion be cost prohibitive for this type of stabilization project. We therefore recommend the retaining structure be supported on either large cut limestone blocks rock or gabions and seated into the greenish tan and gray silty clay approximately 5 feet to 8 feet below the existing channel bottom. The larger limestone blocks with approximate size of 2'x2'x4' long are the preferred size stone for the base of the wall.

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These stones must be carefully selected and placed. If these larger stones are not available, then, we recommend that rock gabions be used at the base of the wall. Smaller stones may be used but we recommend tieing stones together with grout, mortar or dry pack concrete. This will provide a massive interlocking wall that will resist pressure from high steam velocity. The large limestone blocks, rock gabions, or mortared stone should extend a minimum of 4 feet above the current channel bottom. Above this level the wall may consist of reinforced earth, rock gabion or stacked boulders. Free draining granular fill must be used to allow drainage through the wall.

The base of the wall should be seated a minimum of 24 inches into the stiff greenish tan and gray silty clay found at approximately 5 feet to 8 feet below the existing channel bottom. At this depth the allowable bearing capacity for the greenish tan and gray silty clay is 4500 PSF. The base of the wall should be seated a minimum of 2 feet below the maximum scour line of the channel bottom. To achieve a seal the base of the wall, we recommend grouting or concreting between the stone or gabion and the exposed cut face of the greenish tan and gray silty clay bearing strata. This will also provide a bond between the base of the wall and the undisturbed clay and help prevent sliding of the wall. For design purposes the resisting force along the base of the wall may be assumed as 450 PSF for the undisturbed greenish tan and gray silty clay.

In order to perform a detailed stability analysis of the slope behind the wall, then, borings must be made uphill of the failed slope section. Equipment access in this area is not feasible to drill test borings and obtain samples. We can, however, provide some basic design criteria for preliminary slope stability analysis. These values will be based on our experience and knowledge of similar sites and similar geological conditions.

PRELIMINARY STABILITY ANALYSIS DESIGN CRITERIA

Material	ϕ	Unit Weight PCF	Cohesion PSF
Light brown silty clay w/rock	18°	105	300
Greenish tan and gray clay	20°	115	450

We reserve the right to review the stability analysis and application of this criteria used in the design of the wall. We can provide consulting services and assistance in analyzing the slope and designing the wall, if requested.

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CLASSIFICATION OF SOILS

The soils found in our borings have been classified according to the OSHA's Rules and Regulations governing Trench Safety and the appropriate soil type is shown below in Table I. Classification was based on the unconfined compression strength of the tested samples, the moisture content, and the Atterberg Limits tests, and the Unified Soils Classification.

Some variation in soil conditions should be anticipated between the borings. Interpretation of soil conditions between borings must be made by the Geotechnical Engineer or the contractor's designated Safety Officer who must have the expertise to make the classification.

Table I

Material	Description	OSHA Soil Type
Alluvial Soils	Light brown silty clay, brown silty sandy clay, light brown and tan clayey sandy silt with rock and gravel	C
Clay	Greenish tan and gray silty clay	B
Limestone	Tan or gray interbedded silt or clayey silt layers, fractured thin to thick bedded.	B*

* Note: For the purposes of trench safety design the limestone rock is classified as unstable rock.

LATERAL EARTH PRESSURE

The uniform laterally distributed soil pressure for trench sharing design may be determined from the following:

$$P = We\ (H + Hs)$$

Where P = Soil Pressure (PSF)
We = Equivalent Weight of Soil (PCF)
H = Depth of Trench (ft.)
Hs = Height of Surcharge (ft.)

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For Soil Classification:

A use We = 40 PCF
B use We = 45 PCF
C use We = 55 PCF

The above values do not include hydrostatic pressure. Use a value of 75 PCF for saturated soil conditions.

CONSTRUCTION CONSIDERATIONS

1. Bearing Pressure and Seating Depth - The base of the wall should be seated 2 feet into the greenish tan and gray silty clay at approximately 5 feet to 8 feet below the existing channel bottom. Allowable bearing value should not exceed 4500 PSF.
2. Excavation - Excavation into the greenish tan and gray silty clay may require hoe ram or rock saw.
3. Groundwater - Groundwater seepage should be expected and pumping of water from sumps created during excavation will be necessary.
4. Trench Safety - Trench shoring or benching and sloping should be used to protect the safety of the workers. All shoring should be installed in accordance with OSHA safety rules and guidelines.
5. Inspection - The excavation of the bearing strata should be inspected by the Geotechnical Engineer prior to beginning of wall construction to verify depth and soundness of strata.

REMARKS

This report has been prepared in order to aid in the evaluation of this property and to assist the architect and engineer in the design of the project. It is intended for use with regard to specific projects discussed in general herein and any substantial changes in locations or grades should be brought to our attention so that we may determine how this may affect our conclusions. If, during the proposed construction, the soil strata are found to differ from that reported here, we should be notified immediately. This report contains soil boring logs which

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are for the purpose of arriving at foundation criteria and are not to be used by the contractor in arriving at rock hardness or rock depth. The procedures, tests, and recommendations of this investigation and report have been conducted and furnished in accordance with generally accepted professional engineering practices in the field of foundations, engineering soil mechanics, and engineering geology. No other warranty is either expressed or implied.

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APPENDIX

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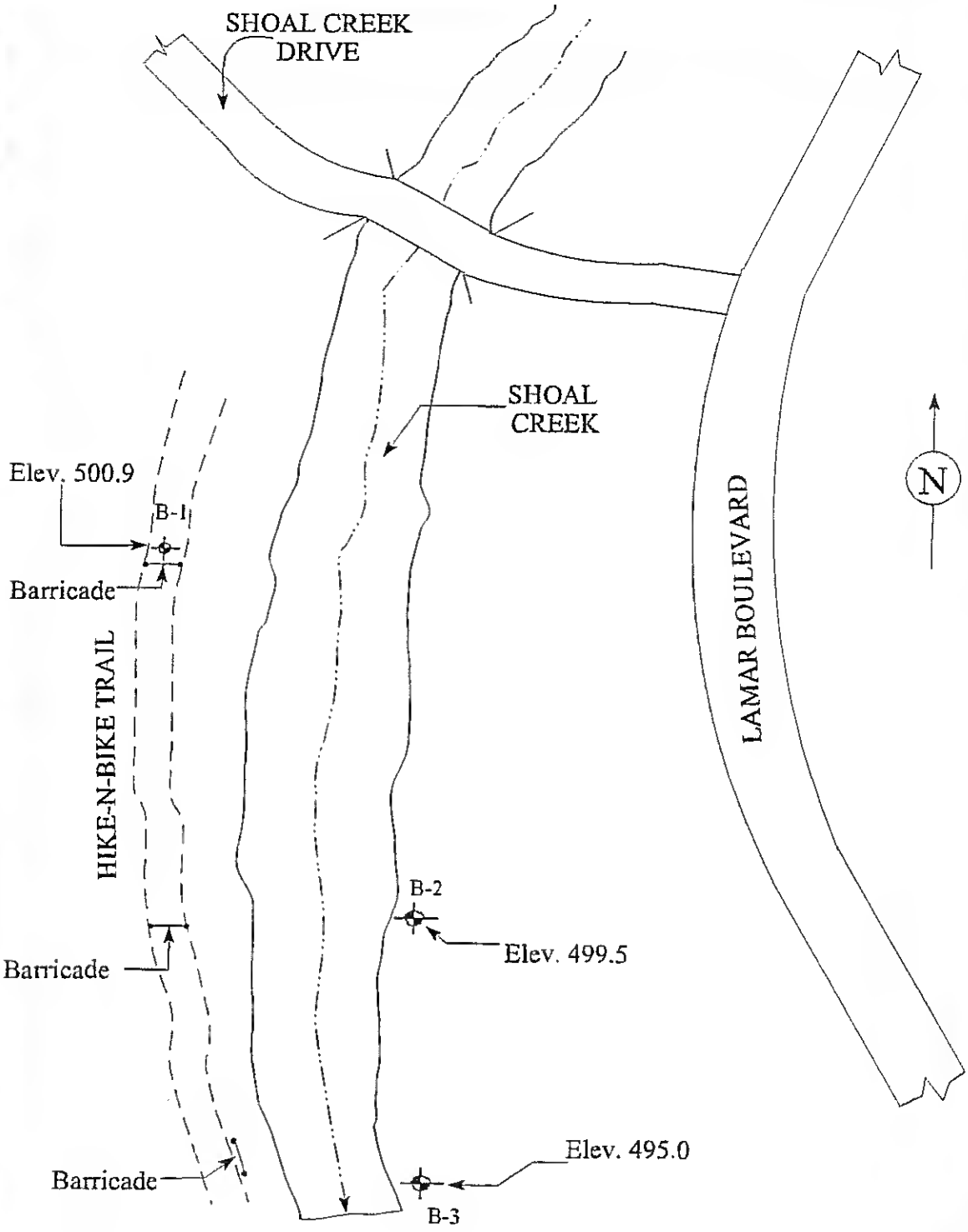

GENERALIZED BORING LOCATION PLAN
LOWER SHOAL CREEK RESTORATION PROJECT
HIKE-N-BIKE TRAIL SLOPE STABILIZATION
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SHOAL CREEK BANK STABILIZATION
2500 NORTH LAMAR BOULEVARD
AUSTIN, TEXAS

LOG OF BORING B-1

DATE DRILLED: *01-22-98* | BORING DEPTH: *30.0 feet*

DRILLER: *John Webb* | WATER LEVEL: *Dry*

DRILLING METHOD: *4 Inch Flight Augers*

NOTES:

Elev. 500.9
Hole dry upon completion of drilling operation.

DEPTH (feet)	SOIL DESCRIPTION	BLOWS PER FOOT	UNCONF.COMP. STR. (TSF)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT %	PLASTICITY INDEX	% PASSING #200 SIEVE
	Base - Tan silt w/limestone fragments							
	Light brown silty clay w/limestone rock							
5		18		18.8	109	80	35	72
	Greenish tan & gray silty clay (stiff)							
10		28		15.2	115	83	40	88
15		35						
20	Gray limestone w/clayey silt layers	50/4"						
25	Gray limestone w/intebedded silty layers	50/1"						
30	Terminated @ 30.0 feet							
35								
40								

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SHOAL CREEK BANK STABILIZATION
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LOG OF BORING B-2

DATE DRILLED: *01-22-98* | BORING DEPTH: *25.0 feet*

DRILLER: *John Webb* | WATER LEVEL: *9.0 feet*

DRILLING METHOD: *4 Inch Flight Augers*

NOTES:

Elev. 499.5
Water encountered at 9.0 feet.

DEPTH (feet)	SOIL DESCRIPTION	BLOWS PER FOOT	UNCONF. COMP. STR. (TSF)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT %	PLASTICITY INDEX	% PASSING #200 SIEVE
	Brown silty sandy clay w/limestone rock & gravel							
5	Tan & light brown clayey sandy silt w/limestone rock & gravel	20		14.2		49	28	81
	▽ Water @ 9'							
10		20						
	Greenish tan & gray silty clay (stiff)			18.5		54	32	81
	-- Becoming light gray							
15		19						
	Gray limestone w/interbedded clayey silt layers							
20	Gray limestone (medium hard to hard)	50/0"						
25	Terminated @ 25.0 feet							
30								
35								
40								

499.50
12.00
487.50

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SHOAL CREEK BANK STABILIZATION
2500 NORTH LAMAR BOULEVARD
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LOG OF BORING B-3

DATE DRILLED: *01-22-98*
BORING DEPTH: *25.0 feet*
DRILLER: *John Webb*
WATER LEVEL: *6.5 feet*
DRILLING METHOD: *4 Inch Flight Augers*

NOTES:
Elev. 495.0
Water encountered at 6.5 feet.

DEPTH (feet)	SOIL DESCRIPTION	BLOWS PER FOOT	UNCONF.COMP. STR. (TSF)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	LIQUID LIMIT %	PLASTICITY INDEX	% PASSING #200 SIEVE
0	Light brown & tan clayey sandy silt w/limestone rock & gravel							
5		24		10.4		42	24	80
	▽ Water @ 6.5'							
	Greenish tan & gray silty clay (stiff)							
10		22		18.9		64	41	94
	Gray limestone w/clayey silt layers	50/6"						
15	Gray limestone w/interbedded silt layers	50/3"						
20		50/0"						
25	Terminated @ 25.0 feet							
30								
35								
40								

494.99
8.50
486.49
499.50